Effects of Advertising on the Demand for Cheese and Fluid Milk

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Economics
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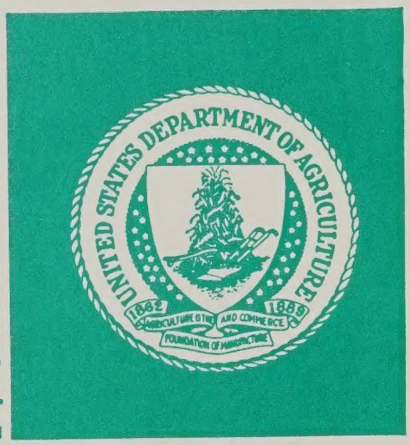

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Abstract

An advertising campaign raised fluid milk sales by about 5,975.4 million pounds during September 1984-September 1990. Natural and processed cheese (consumed at home) sales rose by about 23 and 229 million pounds in the same period. An assessment of 15 cents per hundredweight of milk sold commercially, mandated by the Dairy and Tobacco Adjustment Act of 1983, funded the increase in advertising. The authors use econometric demand models to introduce variables that would offset or complement dairy-centered advertising. In both branded and generic advertising, changes in market price, income, and the availability of substitute goods are factors that influence the demand for natural and processed cheese.

Keywords: Cheese, fluid milk, advertising, demand, entry, exit, distributed lag, econometric, generic, processed, elasticities.

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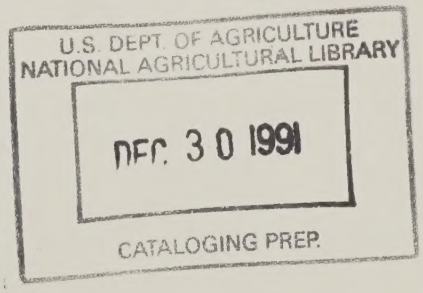

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Contents

Summary

Simulation results show that increased advertising raised fluid milk sales by about 4.4 percent or by 5,975.4 million pounds during September 1984-September 1990. These sales were for milk consumed through all outlets in 12 markets (see appendix). The estimated milk model shows that a 10-percent increase in milk price would result in a 1.5-percent decrease in milk sales. Likewise, a 10-percent increase in income would result in a 2.5-percent increase in milk sales.

The econometric model indicates that the effectiveness of generic milk advertising has increased every year since the implementation of the 1983 Tobacco and Dairy Adjustment Act (ACT). In addition, analysis indicates that the negative downward trend in milk consumption that occurred in the pre-act period has been reversed, at least for the 12 regions represented in the milk model.

Females, households with children under 18 years of age, and single-person households have a positive impact on milk consumption; black and rural households have a negative effect. In addition, as the average level of education of the population increases, the quantity of milk consumed declines.

Simulation results show that increased advertising raised national natural cheese sales by about 23 million pounds and national processed cheese sales by about 229 million pounds during September 1984-June 1990. These sales were for cheese consumed at home. Declining real prices of natural cheese increased sales by about 645 million pounds. Increasing real incomes raised natural cheese sales by 487 million pounds and processed cheese sales by about 17 million pounds.

Generic advertising of cheese does not influence households that normally purchase natural cheese to increase their purchases, but it does influence households that do not normally purchase cheese to purchase natural cheese. Advertising affects the number of households that purchase processed cheese and leads to increased purchases by those households that normally purchase processed cheese.

An assessment of 15 cents per hundredweight of milk sold commercially, mandated by the Dairy and Tobacco Adjustment Act of 1983, funded the advertising. The authors used estimated econometric demand models to simulate these results.

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Introduction

Both advertisers and producers of goods and services would like to know how advertising affects the demand for a particular product. Each year millions of dollars are spent on advertising in the hope that the public can be persuaded to purchase new products or to make additional purchases of goods already being consumed. In 1983, the Dairy and Tobacco Adjustment Act (Public Law 98-180) authorized a national program for dairy product promotion, research, and nutrition education as components of a comprehensive strategy to reduce milk supplies and increase consumption of milk and dairy products.

This study reports on research to determine the effect of advertising on the demand for fluid milk and natural and processed cheese. Specifically, the objectives of this study were to:

(1) Determine what, if any, effect generic and branded advertising has on the demand for natural and processed cheese and fluid milk.

(2) Determine if advertising increases the average quantity of cheese purchased by consumers, or if it induces consumers to enter the cheese market, or if it does both.

(3) Determine if the coefficient of the generic advertising variable changed over time in both the cheese and fluid milk models.

We obtained data and estimated a demand equation for fluid milk sales in 12 geographic regions of the United States from December 1978-September 1990. We specified a second-order polynomial distributed lag with 12 lagged time periods to capture the dynamic aspects of the advertising variable.

Our results indicate that advertising has a statistically significant effect in increasing fluid milk sales in the regions studied. In addition, the model indicates that the effectiveness of advertising has increased in magnitude each year since the inception of the act. Likewise, trend variables which are included in the model to account for unexplained gradual changes in fluid milk consumption have become positive since inception of the act.

Our analysis of the data and simulation results indicate that over the September 1984-September 1990 period a total of $153,468,183 was spent on

fluid milk generic advertising in the 12 regions. Since the inception of the act, generic advertising was found to increase fluid milk sales by approximately 5,975.4 million pounds, or about 4.4 percent, assuming that advertising would continue at pre-act levels even if the legislation had not been enacted.

We estimated national demand equations for natural and processed cheese purchases for at-home consumption during the January 1982-June 1990 period. We specified a gamma distributed lag to capture the dynamic aspects of the advertising variables. We chose the gamma lag because it is a flexible function that does not require a specified lag length. We feel that this choice allows the data to play a larger role in determining the shape of the lag structure. In addition, both the natural and processed cheese equations allowed the coefficient of generic advertising to vary over time.

We determined that generic advertising was statistically significant in increasing the demand for natural cheese, but branded promotion was not. We determined that generic advertising influences consumption only in the current period. We did not find any evidence indicating that the coefficients on generic advertising had been changing over time.

Our results for processed cheese were not meaningful when we divided advertising into branded and generic variables. However, when we combined the variables, we found that advertising had a statistically significant influence on cheese consumption. This influence was largest in the current month and declined slowly, with 12-month-old advertising having about 40 percent of the effect of current period advertising.

Because of the availability of household panel data we were able to estimate two additional equations each for both natural and processed cheese. These equations allowed us to determine if advertising induces consumers to enter the natural (processed) cheese market or to make larger purchases of natural (processed) cheese.

Our results also indicate that generic advertising increased the proportion of consumers entering the natural cheese market, but that it did not induce those already in the market to increase their purchases. Branded advertising was found to have no effect on either variable. In the other two processed cheese equations, advertising increased the proportion of consumers in the market, and it induced those already in the processed cheese market to increase their purchases.

Background on Advertising

Advertising is directed toward existing and potential consumers of a product with the objective of enhancing sales. "Branded" advertising promotes the particular characteristics of a given "brand" of the commodity. "Generic" advertising promotes consumption of the general commodity by a cooperative effort of producers.

Sheth (1974) identifies four separate mechanisms through which advertising produces potential changes in consumer demand: precipitation, persuasion, reinforcement, and reminder. Precipitation encourages consumers to become buyers of a product. Persuasion encourages consumers to choose among alternative "brands" within a product category. Reinforcement continually

directs the consumer's attention to a particular brand or product. Reminder encourages consumers to become repeat purchasers of the product. Ward, Chang, and Thompson (1985) note that generic advertising is intended to precipitate and remind, and branded advertising is intended to persuade and reinforce. The reminder and precipitation functions are more likely to increase total industry sales, and persuasion and reinforcement are generally associated with maintaining or increasing market shares.

Some evidence, at least for a few commodity groups, suggests that generic advertising does increase aggregate demand or at least reduces the rate of decline in consumption (Ward and Myers, 1979; Thompson, 1975; Ward, 1984). The empirical evidence that branded advertising is effective in increasing aggregate demand is less persuasive. Generic advertising, in theory, is brand neutral, but this may not always be the case if generic promotion emphasizes the common characteristics of a product group, and a concurrent branded advertising campaign stresses differences. Also, if one firm dominates the branded advertising for a particular product (such as in the processed cheese market), branded advertising may be serving both as a form of branded and generic promotion. Concurrent generic and branded advertising campaigns can have both complementary and competitive aspects, depending on the commodity and the nature of the promotion activities.

Ward, Chang, and Thompson (1985, p. 275) attribute the following traits to generic advertising:

(1) Generic advertising encourages consumption and repeat purchases of a product category.

(2) Generic advertising provides information about product groups and would generally be expected to be less persuasive (and less deceptive) than branded messages.

(3) Generic advertising probably has more factual information than branded advertising, but it is still oriented to high recall versus the kinds of messages one would expect from promoting infrequently purchased goods.

(4) Generic advertising may have a negative effect on product differentiation, thus reducing barriers to entry and excessive profits (and margins) among first handlers beyond the farm gate.

(5) Generic advertising is likely to force brand advertisers to concentrate on product attributes (whether real or fancied) that are more difficult for the consumer to verify.

(6) Generic advertising may provide producers and smaller firms with a mechanism for benefiting from any economies of scale.

Advertising and Demand Theory

The classical theory of consumer demand postulates that a consumer maximizes a utility function subject to a budget constraint. The result of this process is a set of demand relations, one for each commodity, which are functions of all prices and income. Several restrictions have been shown to apply to demand functions. (See Phlips, 1974, for a discussion of these restrictions.)

Few empirical analyses have attempted to estimate a complete system of consumer demand functions for food. Notable exceptions include Brandow (1961), George and King (1971), and Huang (1985). Estimation of complete demand systems requires information on prices and other demand factors for every commodity. If the focus of the analysis is on a single commodity and if variables other than prices and income are incorporated, the data requirements quickly become so extensive that the analysis becomes almost unmanageable. Thus, almost all examinations of the effect of advertising on consumer demand for a particular product have pragmatically focused on single-equation demand relations.

Two approaches for incorporating advertising into the neoclassical theory of demand have predominated in the economic literature: the "advertising as information" approach and the "advertising as utility altering" approach. Neither of these approaches has reached a refined state of theoretical or empirical development. However, the "advertising as information" approach is overwhelmingly preferred because of the simplicity it implies for empirical applications.

The "advertising as utility altering" approach has as its foundation the premise that advertising, in some fashion, changes the consumers' utility function via its effects on consumer tastes and preferences. No economic theory exists that systematically explains the effect of advertising on consumers' tastes and preferences.

The "advertising as information" approach, as summarized by Rosen (1980) and refined by Verma (1980), is grounded in the theory of household production, which assumes that individual households combine information, time, and market goods to produce commodities that create utility for the household. In this approach, the household can be viewed as a small factory producing a number of commodities, some perhaps unobservable, in such a way as to maximize the household's well-being. Household demand functions for market goods are derived from the demand for these "home-produced" commodities and are constrained by the household's production technology. Advertising, to the extent that it provides low-cost information to the household, represents a cost-saving factor. Thus, the amount of advertising exposure a household receives helps determine its productivity in supplying household commodities and hence alters implicit prices. The major advantage of viewing advertising as information is that it can be introduced as an exogenous factor into the consumer demand function for a particular good, along with traditional factors, including market prices, income, and other demand determinants.

Fluid Milk Model Specification

The data set for the milk model consists of 12 different regions (see appendix) within the United States (10 milk marketing orders plus California and northern Virginia). Thus, the possibility exists for estimating separate models for each region. However, preliminary results suggest that there is insufficient variability among the independent variables within a region to clearly identify the effect of what are believed to be important economic variables. Thus, we decided to pool the data. Pooling implies that data from various regions are combined into one model such that the coefficients of the independent variables are restricted to be constant across regions. Moreover, because the data are time-series in nature, it is likely that the stochastic error terms within each region are correlated over time and also

contemporaneously correlated across regions for a given period. Because of these characteristics, a Parks model for combining time-series and cross-sectional data into a constant coefficient model was selected for use. Demographic variables are included to account for geographic variations in consumer characteristics. Essentially, the coefficients are estimated using what is known as a generalized least squares estimator. The fluid milk model estimated here was originally developed by Ward and Dixon in 1989.

Aside from advertising, many other factors influence the per capita quantity of milk purchased, including the price of the product, income, seasonality, time trends, and demographic factors. The single-equation demand model was estimated in double-log form. We hypothesize that the log of the average daily per capita amount of milk consumed per region is a function of the log of deflated milk price per half gallon and the log of deflated per capita income across regions. Demographic variables are represented by the log of the percentage of a region's population under 18 years of age, the log of the percentage of a region's population that is black, the log of the percentage of a region's population that lives in rural areas, the log of the percentage of a region's population that is female, the log of the percent of a region's households that are single-person households, and the log of the median number of years of education for individuals over 25 years of age.

The log of advertising is expressed as a restricted polynomial with advertising measured in real per capita advertising expenditures. The log of time, a trend variable, is entered to capture the persistent downward trend in milk consumption that is evident in the data. Dummy variable shifters for the time variable were specified for each year since implementation of the act in order to determine if advertising might have some influence in reversing the downward trend in milk consumption. Dummy variable shifters for the advertising variable were specified, one for each year since the inception of the act, in order to determine if the magnitude of the advertising coefficient changes over time. Dummy variable shifters for each month of the year, excluding December to avoid perfect multicollinearity, were specified in order to take into account seasonal patterns in the consumption of milk.

The demand model for fluid milk can be written as follows:

$$\begin{aligned} Lnpcads_{it} = B_0 &+ B_1\ Lnmapr_{it} + B_2\ Lndpcin_{it} + B_3\ Lnnu18 \\ &+ B_4\ Lnfem_{it} + B_5\ Lnblk_{it} + B_6\ Lnrur_{it} + B_7\ Lnhous_{it} \\ &+ B_8\ Lnschl_{it} + B_9\ Lnadver_{it} + B_{10}\ Adv1_{it} + B_{11}\ Adv2_{it} \\ &+ B_{12}\ Adv3_{it} + B_{13}\ Adv4_{it} + B_{14}\ Adv5_{it} + B_{15}\ Adv6_{it} \\ &+ B_{16}\ Lntime_{it} + B_{17}\ TT1_{it} + B_{18}\ TT2_{it} + B_{19}\ TT3_{it} \\ &+ B_{20}\ TT4_{it} + B_{21}\ TT5_{it} + B_{22}\ TT6_{it} + B_{23}\ DJan_{it} \\ &+ B_{24}\ DFeb_{it} + B_{25}\ DMar_{it} + B_{26}\ DApr_{it} + B_{27}\ DMay_{it} \\ &+ B_{28}\ DJun_{it} + B_{29}\ DJul_{it} + B_{30}\ DAug_{it} + B_{31}\ DSep_{it} \\ &+ B_{32}\ DOct_{it} + B_{33}\ DNov_{it} + \epsilon_{it}. \end{aligned}$$

The error term ϵ_{it} is hypothesized to follow a first-order autoregressive pattern as follows:

$$\epsilon_{it} = \Pi_i\ \epsilon_{it-1} + \eta_{it}$$

where the expected value of η_{it} is σ^2_{it} if $t = t'$, or 0 otherwise, and η_{it} and η_{jt} are contemporaneously correlated.

The variables of the above model are defined as:

Lnpcads:	Log of the average daily ounces consumed per capita by region and month.
Lnmapr:	Log of the deflated milk price per half gallon with price reported by the Market Administrator for selected U.S. cities.
Lndpcin:	Log of the deflated per capita income across regions and over time.
Lnnul8:	Log of the percent of a region's population under 18 years of age.
Lnblk:	Log of the percent of a region's population that is black.
Lnrur:	Log of the percent of a region's population that lives in rural areas.
Lnfem:	Log of the percent of a region's population that is female.
Lnhous:	Log of the percent of a region's households that are single-member households.
Lnschl:	Log of the median number of years of education for individuals over 25 years of age.
Lnadver:	A restricted polynomial lagged model with advertising measured in real per capita expenditures.
Lntime:	Log of the variable time.
T1:	Slope shifter for time, 4/84 - 8/85.
T2:	Slope shifter for time, 9/85 - 9/86.
T3:	Slope shifter for time, 10/86 - 9/87.
T4:	Slope shifter for time, 10/87 - 9/88.
T5:	Slope shifter for time, 10/88 - 9/89.
T6:	Slope shifter for time, 10/89 - 9/90.
Adv1:	Slope shifter for advertising 4/84 - 8/85.
Adv2:	Slope shifter for advertising 9/85 - 9/86.
Adv3:	Slope shifter for advertising 10/86 - 9/87.
Adv4:	Slope shifter for advertising 10/87 - 9/88.
Adv5:	Slope shifter for advertising 10/88 - 9/89.
Adv6:	Slope shifter for advertising 10/89 - 9/90.
DJan:	Seasonal dummy variable for January.
DFeb:	Seasonal dummy variable for February.
DMar:	Seasonal dummy variable for March.
DApr:	Seasonal dummy variable for April.
DMay:	Seasonal dummy variable for May.
DJun:	Seasonal dummy variable for June.
DJul:	Seasonal dummy variable for July.
DAug:	Seasonal dummy variable for August.
DSep:	Seasonal dummy variable for September.
DOct:	Seasonal dummy variable for October.
DNov:	Seasonal dummy variable for November.

National electronic and print advertising expenditures were deflated by their respective cost indexes. Regional electronic media advertising expenditures were deflated by regional media cost indexes. All media cost indexes were supplied by the United Dairy Industry Association (UDIA).

Advertising data for 11 regions (excluding California) were obtained from UDIA. National fluid milk advertising was supplied by the National Dairy Board (NDB). Milk prices for the 11 regions were supplied by the Milk Marketing Administrator at the Agricultural Marketing Service, USDA.

California milk prices and advertising data were supplied by the California Milk Advisory Board. Demographic data were generated from two actual observations taken from the decennial census data of April 1, 1970, and April 1, 1980.

Empirical Results of the Fluid Milk Model

Table 1 presents the parameter estimates for the fluid milk model. The estimated equation provides a reasonably good statistical fit to the data and was estimated assuming first-order autocorrelation across the regions. Most parameter estimates have the expected signs and are of a reasonable magnitude.

The log of the advertising variable was found to be statistically significant at a level greater than 1 percent. In addition, the advertising shift variables are all statistically significant at a level of 5 percent or higher, except for the 4/84-8/85 (Adv1) shift variable. This indicates the coefficients for the advertising shift variables are larger and statistically different from the pre-act base period.

The milk price variable coefficient had the expected sign (negative) and indicates that if milk prices rose by 10 percent, the quantity of milk consumed would decline by approximately 1.5 percent, other factors constant. Likewise, the coefficient for the income variable indicates that if per capita real disposable income rose by 10 percent then milk consumption would increase by approximately 2.5 percent.

The demographic variables generally have the expected signs although the negative sign on the average amount of education is somewhat surprising. This variable indicates that if the average amount of education of the population rose by 10 percent then the per capita quantity of milk consumed would decline by approximately 6.6 percent. Likewise, if the percentage of the population that is black rose by 10 percent then the quantity of milk consumed per capita would decrease by approximately 1 percent. Contrasted to this, if the number of females in the population rose by 10 percent then the quantity of milk consumed per capita would increase by approximately 19 percent. Also, if the percentage of the population under 18 years rose by 10 percent, the amount of milk consumed per capita would rise by about 6.2 percent. Finally, if the percentage of single-member households rose by 10 percent, then the per capita quantity of milk consumed would increase by approximately 4 percent.

Note that the log of the time trend variable has the expected negative sign, and is statistically significant at a level greater than 5 percent. Interestingly, the time shift dummy variables and the time shift dummy variables interacted with advertising are all positive and statistically significant except for the first time period. This indicates that, over time, the negative trend in milk consumption was at first slowed, and then reversed in later years. To see this, first note that up to the implementation of the act, the coefficient for the log of the time trend variable (Lntime) is negative, -0.05. Six years after the passage of the act, the coefficients for the time shift variable (TT6) and the time shift variable interacted with advertising (Adv6) are both positive and equal to 0.12 and 0.05, respectively. To calculate the estimated value of the time trend coefficient in the most current period, the coefficients for TT6 and Lntime are added together along with the sum of Adv6 multiplied by the current level of advertising. This summation is positive. Hence, we reach the conclusion that the negative trend

Table 1--Summary of fluid milk model estimates, September 1990

Variable	Coefficient	Standard error	T-test
Intercept	5.056381	0.30652	16.49614
Lnmapr	-.147298	.014264	-10.32641
Lnpcin	.248619	.022943	10.83644
Nu18	.618176	.040166	15.39067
Fem	1.902676	.263014	7.23412
Blk	-.099590	.00223	-44.72679
Rur	-.02068	.00358	-5.76951
Hous	.39741	.03596	11.04912
Schl	-.660995	.07626	-8.66816
Lnadver	.010837	.00250	4.33944
Adv1	.004509	.00611	.73752
Adv2	.016765	.00848	1.97718
Adv3	.021973	.00794	2.54303
Adv4	.027597	.00799	3.45591
Adv5	.034028	.00966	3.52228
Adv6	.049632	.01154	4.30181
Lntime	-.047840	.01560	-3.06589
TT1	.010486	.01448	.72430
TT2	.039183	.01885	2.07852
TT3	.050981	.01795	2.84005
TT4	.068327	.01762	3.87715
TT5	.084016	.02086	4.02806
TT6	.120819	.02506	4.82157
Djan	.027401	.00394	6.94605
Dfeb	.028667	.00502	5.70513
Dmar	.032260	.00559	5.77151
Dapr	.010833	.00591	1.83249
Dmay	-.0115824	.00609	-1.902405
Djun	-.0619822	.00617	-10.05156
Djul	-.0722638	.00616	-11.73468
Daug	-.0369236	.00605	-6.70267
Dsep	.0252490	.00573	4.40556
Doct	.0321537	.00517	6.21799
Dnov	.0215641	.00409	5.27581

Estimated values of rho

Cal 0.7302	Mic 0.9447
Col 0.6184	Eng 0.8134
Fla 0.6567	Alt 0.8100
Gbs 0.5600	Tex 0.6516
Geo 0.7028	Umw 0.6415
Kan 0.7212	Vir 0.8303

No. of cross sections = 12

No. of time series = 142

Total observations = 1704

R^2 = .8976 MSE = .0023 PRMSE = 2.1868 MABSER = .0183

in milk consumption has been reversed after adjusting for other factors since passage of the act for the 12 regions. We cannot directly conclude that the act is responsible for this reversal, but expanded generic advertising may have played a part.

Finally, most of the monthly dummy variables are positive except May-August. Milk consumption traditionally declines in these months because of school closing for the summer. Hence, we have confidence that the monthly dummy variables have captured the seasonal consumption patterns for milk.

Simulation of the Fluid Milk Model

The statistical error associated with the fluid milk model is small enough to permit a statistically founded conclusion that advertising increases the demand for fluid milk in the 12 regions studied. Thus, we can use the estimated demand equation for generic advertising with sufficient confidence to simulate the total effect of advertising on milk purchases. We used the following procedures to simulate the effect on milk purchases of increased generic advertising after passage of the 1983 Act. First, we simulated per capita consumption from the milk equation using the actual levels of generic advertising deflated for media cost increases. Next, we simulated per capita consumption by assuming that generic advertising remained at the monthly per capita levels of the year prior to the implementation of the act, September 1983-August 1984. For this procedure, we assumed that, in the absence of the act, generic advertising dollars spent would have remained at the $18.5 million annual level of the above-mentioned year. We then estimated per capita consumption of fluid milk on a monthly basis over September 1984-September 1990. The only factor that differed between the simulations was the level of generic advertising expenditures. We kept all other factors at actual levels observed during the period. The difference in per capita consumption between the simulations is an estimate of the effect of the act for the 12 regions under study (table 2).

Results of the simulation indicate that increased generic advertising expenditures due to the enactment of the act increased fluid milk consumption in the 12 regions by 5,975.4 million pounds. We can conclude that the gain in fluid milk sales directly related to the implementation of the act amounted to approximately 4.4 percent of total sales over the September 1984-September 1990 period (136,304 million pounds).

Marginal sales gains can also be derived from increases in fluid milk advertising. In other words, how much additional milk could be sold if expenditures were increased by various amounts. Table 3 shows marginal sales gains from advertising with 5-percent increases in advertising expenditures. The results indicate that sales increase but at a decreasing rate as real advertising expenditures increase. If advertising expenditures increase from $153.47 million to $161.14 million, fluid milk sales will increase by 270.44 million pounds. The marginal gain drops to 261.32 million pounds for the next 5-percent increase in advertising expenditures. The last column of table 3 shows the marginal sales gains per advertising dollar at each of the advertising intensity levels. Thus, at the actual advertising level of $153.47 million, one additional advertising dollar is estimated to result in 35.26 pounds of additional milk sales.

Table 2--Summary of model simulation results on the effect of regional and national generic milk advertising, September 1984-September 1990

Item	Sales/advertising results
Total sales of fluid milk	136,304 million lb.
Estimated increase in national and regional advertising expenditures due to act	$38,810,735
Fluid milk sales gain due to advertising	5,975.4 million lb.
Fluid milk sales gain as a share of total sales	4.4 percent

Table 3--Estimated changes in fluid milk sales associated with incremental increases in post-act advertising

Proportion of actual advertising	Total post-act advertising	Increase in sales	
	Million dollars	Million pounds	Pounds/dollar
1.00	153.47	280.34	36.55
1.05	161.14	270.44	35.26
1.10	168.82	261.32	34.07
1.15	176.91	252.50	32.92
1.20	184.16	245.13	31.96

Table 4--Tradeoff between advertising and fluid milk prices to keep sales constant in the post-act period

Constant fluid milk sales = 136,304 million lbs.

Proportion of actual advertising	Adjustment in price
Percent	Percent
100	0
95	-1.4
90	-2.9
85	-4.5
80	-6.2
75	-7.9

Advertising is not the only way to increase sales of fluid milk. An alternative would be to lower retail prices. The change in retail price that is necessary to offset a decrease in the advertising of milk was estimated. That is, we computed the percentage change in prices required to keep demand constant for a corresponding change in advertising expenditures. Table 4 shows the approximate tradeoffs between advertising and prices. If advertising were only 75 percent of the actual levels during the post-act period, prices would have had to decline by approximately 8 percent in order to maintain the total sales level of 136.3 billion pounds.

Entry and Exit in the Cheese Market

The preceding discussion of the theory of demand and of advertising has ignored what may be a significant analytical component: the effect of individual consumers or households beginning or ceasing to purchase a given commodity. Not all consumers will purchase a given commodity at all given prices. Rather, some consumers will choose not to purchase any of a given good at certain relative prices. As variables in the demand function change, including prices, income, and advertising expenditures, some individuals will decide to enter the market, while others may decide to exit.

Advertisers may try to increase consumption by getting more consumers to enter the market, by getting those already in the market to increase their purchases, or by both methods. Haidacher (1964) developed a methodology for estimating the effect on the demand for a given good due to consumers entering and exiting the market. His methodology is pertinent to studies, such as this one, that use aggregated data, rather than studies that use data for individual households. The latter studies would probably have a certain number of zero observations representing individuals or households not in the market. Analysis of data containing explicit zero observations would require the use of some type of limited-dependent-variable model.

The entry-exit phenomenon and its component parts can be easily demonstrated by focusing upon the own-price elasticity for any good. First, at prices above some minimum level, N - r consumers will not purchase the commodity (N is the maximum number of potential consumers (assumed fixed), and r is the number of consumers actually purchasing the product). The proportion, Pr, of consumers purchasing at a given price is r/N. Next, we define the average quantity purchased by individuals in the market as:

$$q = 1/r \sum_{i=1}^{r} q_i. \tag{1}$$

The summation of q_i over all consumers in the market is aggregate demand or Q; thus,

$$Q = q * r. \tag{2}$$

Then, because r = Pr*N, we simply substitute to get

$$Q = q * Pr * N. \tag{3}$$

Own-price elasticity is defined as:

$$E_Q = \delta Q/\delta P_1 * P_1/Q. \tag{4}$$

However, if we define Q in terms of the entry and exit phenomena, our formula for elasticity will be

$$E_Q = (\delta q/\delta P_1) * P_1/q + (\delta PrN)/\delta P_1 * P_1/(PrN), \tag{5}$$

or, because N can be considered a constant for variations in P_1,

$$E_Q = \delta q/\delta P_1 * P_1/q + \delta Pr/\delta P_1 * P_1/Pr, \text{ or} \tag{6}$$

$$E_Q = E_q + E_{Pr}. \tag{7}$$

Hence, the own-price elasticity of market demand for any good consists of two components: the effect on the elasticity of average quantity purchased by consumers in the market, and the effect on the elasticity of the proportion of total consumers in the market.

We can estimate two additional equations to determine if changes in the quantity demanded for a good are due to consumers already in the market changing the average quantity purchased, or due to a change in the proportion of consumers in the market, or due to both effects. As demonstrated, these two equations are a breakdown of the ordinary demand curve. The same variables that enter into the ordinary demand curve are expected to enter into the average quantity purchased curve and the proportion of consumers in the market curve. The summation of the estimated coefficients for a given variable from the two curves should equal the corresponding estimated coefficient in the ordinary demand curve.

Because we have consumer panel data for cheese that include information on the average quantity purchased by consuming households and the proportion of households buying cheese, we are able to construct and estimate several different types of models that are not possible with the data used for estimating the fluid milk model. This methodology allows us to determine if cheese advertising is affecting the proportion of consumers entering the market or increasing the quantity purchased by those already in the market, or both.

Time-Varying Parameter Models

In our work, we test the hypothesis that increased generic advertising has caused the generic advertising coefficient to change over time. We assume that the response to generic advertising may change over time as the public continues to see and read generic cheese advertisements, as the quality of the ads changes, or as the overall advertising strategy is refined. As the response to advertising changes, the coefficient of the generic advertising variable may also change, so that a given level of advertising generates

increasing, decreasing, or static sales. By allowing the advertising parameter to change over time, we may get a model that better describes the dynamic relationship between advertising and sales.

Time-varying parameter models (tvpm) are a generalization of dynamic regression models where particular coefficients are lagged one or more time periods. In the tvpm, some coefficients are hypothesized (either deterministically or stochastically) to vary over time, whereas the parameters of a conventional regression model are assumed constant over time. The tvpm attempts to shrink the forecasting error of the model in question by varying a specified regression coefficient, thereby achieving a better fitting model.

The basic equation for the tvpm is as follows:

$$y_t = H_t X_t + BZ_t + e_t \tag{8}$$

where y_t is the observation at time t, H_t is a corresponding vector of time-varying regression coefficients, X_t is a vector of explanatory variables, B is a corresponding vector of fixed regression coefficients, Z_t is a vector of explanatory variables, and e_t is the raw residual at time t. In equation 8, it is assumed that the time-varying coefficient can be modeled as a random walk:

$$b_t = b_{t-1} + v_t. \tag{9}$$

With this specification, parameter b_t will drift over the course of the data, usually with an obvious trend reflecting continuing change of the parameter if it indeed changes over the sample period.

Specification of the Cheese Models

Aside from advertising, many other factors influence the per capita quantity of cheese purchased, including the price of the product, prices and availability of substitute and complementary products, income, seasonality, trends, and Government donations. To isolate and measure the effects of advertising, one must account for and control the effect of these variables on quantities demanded. Processed and natural cheese purchase patterns, prices, and product characteristics are sufficiently different as to warrant separate analyses for each product. Among these differences are the following:

(1) Natural cheese purchases vary significantly by month and season, with a peak in December and a trough in July. Processed cheese purchases, however, vary much less from season to season.

(2) Government donations of cheese under the Temporary Emergency Food Assistance Program were predominantly processed cheese. Hence, we would expect these donations to have a greater effect on purchases of processed cheese than on purchases of natural cheese.

(3) Because natural cheese is a higher priced product than processed cheese, price and income probably have greater effects on purchases of natural cheese.

The demand and the entry and exit models for natural cheese can be written as follows:

$$Ln Q_t^n,\ Ln q_t^n,\ Ln P_r^n = \tag{10}$$

$$\beta_0 + \beta_1 Ln(P_t^n) + \beta_2 Ln(P_t^p) + \beta_3 Ln(P_t^m) + \beta_4 D_t + \beta_5 Ln(Y_t) + \beta_6 T_t + di \sum_{j=1}^{11} d_i M_i + \alpha_1 \sum_{i=0}^{t-1} (i+1)^{c/(1-c)} L^i [1/(k_1 + A_{t-i}^g)] + \alpha_2 \sum_{i=0}^{t-1} (i+1)^{s/(1-s)} H^i [1/(k_2 + A_{t-i}^b)] + \epsilon_t$$

where

Q_t^n : per capita quantity of natural cheese purchases by U.S. households, in pounds per month t, t = 1 (January 1982)..., t = 102 (June 1990);

q_t^n : average per capita quantity of natural cheese purchases by U.S. households purchasing natural cheese, in pounds per month t, t = 1 (January 1982)..., t = 102 (June 1990);

P_r^n : the proportion of all U.S. households that purchased natural cheese during month t, t = 1 (January 1982)..., t = 102 (June 1990);

P_t^n : price of natural cheese in dollars per pound, deflated by the Consumer Price Index (CPI) for all urban consumers (1977 = 100);

P_t^p : price of processed cheese in dollars per pound, deflated by the CPI;

P_t^m : price index for meat, poultry, and fish (1967 = 100) deflated by the CPI;

Y_t : per capita disposable income in the United States in period t, deflated by the CPI;

D_t : per capita domestic donations of cheese in pounds under the USDA's Temporary Emergency Food Assistance Program;

T_t : time trend, T = 1 if t = January 1982..., T = 102 if t = June 1990;

M_i : monthly dummy variables, M_1 = 1 if i = January, zero otherwise, M_2 = 1 if i = February, zero otherwise, and so forth. December is omitted to avoid perfect multicollinearity.

$\alpha_1 \sum_{i=0}^{t-1} (i+1)^{c/(1-c)} L^i [1/(k_1 + A_{t-i}^g)]$:

weighted average of current and past per capita generic advertising

expenditures on natural cheese. Generic advertising expenditures are "deflated" by a media cost index.

The terms represented by $(i+1)^{c/(1-c)}\ L^i$ are weights placed on present and past advertising expenditures assuming a gamma lag structure where the values of the weights and general shape of the weight structure are determined by parameters c and L. k_1 is an advertising constant (for example, word-of-mouth or other advertising that has a residual presence at any given time even if no generic advertising took place);

$$\alpha_2 \sum_{i=0}^{t-1} (i+1)^{s/(1-s)}\ H^i[1/(k_2 + A^b_{t-i})]:$$

weighted average of current and past per capita branded advertising expenditures on natural cheese in period t. Branded advertising expenditures are "deflated" by a media cost index.

The terms represented by $(i+1)^{s/(1-s)}\ H^i$ are the weights placed on present and past advertising expenditures assuming a gamma lag structure where the values of the weights and general shape of the weight structure are determined by parameters s and H. k_2, like k_1, is an advertising constant.

d_i, ß's, α_1, α_2, c, s, L, and H are model parameters to be estimated; α_1 and α_2 will also be modeled as time-varying parameters; ϵ_t : first-order autoregressive equation error term where $\epsilon_t = \rho\epsilon_{t-1} + \mu_t$ and μ_t is assumed to be normally distributed with zero mean and constant variance.

The processed cheese models can be written mathematically as:

$$Ln Q^p_t,\ Ln\ q^p_t,\ Ln\ P^p_r = \tag{14}$$

$$\beta_0 + \beta_L\, Ln(P^p_t) + \beta_2\, Ln(P^n_t) + \beta_3\, Ln(P^I_t) + \beta_4\, Ln(P^m_t)$$
$$+ \beta_5\, Ln(Y_t) + \beta_6\, Ln(D_t)$$
$$+ \alpha_1 \sum_{i=0}^{t-1} (i+1)^{c/(1-c)}\ L^i[1/(k_3 + A^g_{t-i})]$$
$$+ \alpha_2 \sum_{i=0}^{t-1} (i+1)^{s/(1-s)}\ H^i[1/(k_4 + A^b_{t-i})] + \epsilon_t$$

where all variables are as defined in the natural cheese equation, except the following:

Q^p_t : per capita quantity of processed cheese purchases by U.S. households, in pounds per month t, t = 1 (January 1982)..., t = 102 (June 1990);

q^p_t : average per capita quantity of processed cheese purchases by U.S. households purchasing processed cheese, in pounds per month t, t = 1 (January 1982)..., t = 102 (June 1990);

P^p_r : the proportion of all U.S. households in the processed cheese

market during month t, t = 1 (January 1982)..., t = 102 (June 1990);

P_t^I : price of imitation cheese in dollars per pound, deflated by the CPI for all urban consumers (1977 = 100).

We obtained from the National Dairy Board proprietary data collected by the Market Research Corporation of America (MRCA). The data were for all cheese prices (natural, imitation, and processed) and quantities. The time series data on household cheese purchases reflect aggregate national purchase data estimated from a continuing consumer panel survey. The data include only cheese purchased for direct consumption at home. Cheese consumed in restaurants or other away-from-home establishments and consumed in connection with purchased foods (for example, pizzas and macaroni and cheese mixtures) are not included. Cheese prices refer to retail prices.

MRCA data are reported in 4-week intervals. Other data in the model are reported on a calendar-month basis. Thus, we had to convert the MRCA data (both prices and quantities) to a calendar-month basis. We used a simple allocation scheme. For example, total consumption in a week that overlapped 2 months was allocated to each month based on the number of days in the month that the week represented. We used the same method to estimate the proportion of households purchasing cheese in a given month. That is, we divided the total number of buying households in a month by the total number of households to calculate the proportion of buying households in a given month. We also adjusted the quantity data so that each calendar month reflected the same number of days, removing any artificial month-to-month seasonal patterns caused strictly by the fact that some months have more days than others. We similarly adjusted disposable income and monthly generic and branded advertising expenditures.

Bureau of Labor Statistics provided the price index for meat, poultry, and fish and the CPI for all items. We obtained personal disposable income figures from the Bureau of Economic Analysis, U.S. Department of Commerce, and U.S. civilian population data from the Bureau of the Census, U.S. Department of Commerce.

One would expect the coefficient on the price of natural cheese to enter the natural models with a negative sign. One would also expect the coefficient on the price of processed cheese to be positively related to natural cheese sales because processed cheese can be regarded as a substitute for natural cheese. The coefficient associated with the price index for meat, poultry, and fish cannot be predicted a priori because whether these commodities can be regarded as substitutes or complements for natural cheese is unclear. Income should have a positive effect on natural cheese usage.

We included Government donations in the model to capture their influence on retail sales. That is, one would expect donations to displace purchases by households receiving the donated cheese. Thus, we expected the sign on the coefficient associated with the donations variable to be negative.

We incorporated a time trend into the natural cheese models to capture the clear downward trend reflected in the MRCA data across years in the purchases of natural cheese for consumption at home. We also included a series of monthly dummy variables in the natural cheese models to capture the seasonal

month-to-month variation in natural cheese purchases that the MRCA data reflect.

Except for the time trend, monthly dummy variables, and advertising expenditures, all other variables are logarithmically transformed. Preliminary analysis indicated that this functional specification provided a good fit to the data and coefficients of reasonable magnitude. Preliminary model specifications indicated that the coefficient associated with a time trend was not statistically significant in the processed cheese equation.

We expected that the price of processed cheese would enter the processed cheese models with a negative sign, that the prices of natural and imitation cheese and income would enter with positive signs, and that Government cheese donations would be negatively related to processed cheese purchases.

Monthly branded advertising expenditures for cheese were supplied by the United Dairy Industry Association (UDIA). UDIA, the National Dairy Promotion and Research Board, Wisconsin Milk Marketing Board, and the California Milk Advisory Board supplied monthly generic promotion expenditures for cheese. On advice from representatives of the National Dairy Board, 25 percent of these groups' calcium advertising expenditures were allocated to generic cheese promotion. Promotion expenditures for both branded and generic advertising represent only the media cost component of advertising. That is, promotion expenditures do not include such items as talent and production costs.

Generic advertising expenditures for cheese increased over 500 percent from 1982 to 1989 (table 5). Branded advertising expenditures increased almost 60 percent from 1982 to 1989. In 1988, branded advertising expenditures increased almost 75 percent from 1987. Media expenditures include radio, television, outdoor, and print. Both generic and branded advertising expenditures were deflated by separate media cost indexes, allowing advertising expenditures to be interpreted as a measure of the quantity of advertising taking place in each time period. Divisia advertising cost indexes were constructed, which are exact for an underlying translogarithmic

Table 5--Estimated generic and branded advertising expenditures for cheese

Period	Generic advertising	Branded advertising
	Million dollars	
1982	5.8	56.4
1983	6.0	57.8
1984	21.7	83.3
1985	56.5	78.9
1986	58.0	73.2
1987	49.7	51.3
1988	42.2	89.5
1989	37.5	85.8
1990, January-June	17.5	55.5

unit cost function. (For details in constructing this type of index, see Diewert, 1976, p. 121.) We constructed the divisia indexes using information on the share of total advertising expenditures spent for each type of media and price indexes for each media type. Monthly advertising expenditures by media type (for both branded and generic advertising) and monthly price indexes by media type were not available. Thus, we constructed quarterly divisia indexes. We obtained the budget shares devoted to each media type for cheese advertising by quarter from various issues of Leading National Advertisers (LNA). In the case of generic advertising, some judgments were required in constructing media shares because LNA did not always separate UDIA advertising expenditures for cheese from other dairy products. Yearly media price indexes by media type were taken from Media Insights, published by the advertising firm of D'Arcy, MacManus, and Masuis. We used that firm's adjustment factors to convert the yearly price indexes to a quarterly basis.

We entered both generic and branded advertising expenditures into the model using an inverse functional form. We chose the inverse form because of the wide range of the advertising expenditure data, especially for generic promotion, and because of its other desirable characteristics.

Direct estimation of the parameters in each of the demand equations is not possible because of the nonlinearities due to the parameters of the gamma distribution. The estimation strategy was to set the parameters c, L, s, and H to fixed values and estimate the remaining parameters in a given equation by ordinary least squares. The procedure was repeated for a wide range of values for c, L, s, and H, and the equation yielding the best statistical fit with plausible parameter estimates was selected. Consequently, the standard errors for the parameters c, L, s, and H are not available. This estimation procedure will also bias the standard errors of other parameters in the model downward.

Empirical Results of the Cheese Demand Models

Tables 6 and 7 present parameter estimates of the natural and processed cheese aggregate demand equations. Both equations provide a reasonably good statistical fit to the data and were estimated with the assumption of first-order autocorrelation. Most parameter estimates have the expected signs and are generally of a reasonable magnitude, but some estimates are not statistically significant at the usual confidence levels.

We also tested the hypothesis that the coefficient of generic advertising was increasing over time. We found that the generic advertising variable was constant in both equations. For example, in the natural cheese demand equation, we found that the fixed parameter estimate for generic advertising was -0.00036. In the time-varying parameter model, we found that the coefficient ranged from -0.00037 to -0.00035 over the estimating period. In the demand equation for processed cheese, we found that the best fitting time-varying parameter model produced estimated coefficients for generic advertising that alternated between positive and negative values. Results were similar for the entry and exit equations. Hence, we conclude that the advertising coefficients for both natural and processed cheese are better modeled as fixed parameters.

We estimated the own-price elasticity for natural cheese to be about -1.2 in the demand equation. Thus, if the price of natural cheese rose by 10 percent,

Table 6--Summary of natural cheese model estimates, January 1982-June 1990

Source	Estimated b values	T for H:b=0	Prob T	Standard error of estimate
Intercept	-8.233	-4.168	0.0001	1.976
log(pn)	-1.203	-4.442	.0001	.271
log(pp)	.846	4.370	.0001	.194
log(pm)	.847	8.792	.0001	.096
log(Y)	.960	3.900	.0002	.246
d	-.002	-3.387	.0011	.001
t	-.005	-7.655	.0001	.001
DJAN	-.146	-8.558	.0001	.017
DFEB	-.244	-8.533	.0001	.029
DMAR	-.159	-10.377	.0001	.015
DAPR	-.215	-14.141	.0001	.015
DMAY	-.214	-13.218	.0001	.016
DJUN	-.251	-15.376	.0001	.016
DJUL	-.266	-15.306	.0001	.017
DAUG	-.232	-12.117	.0001	.019
DSEP	-.225	-12.928	.0001	.017
DOCT	-.174	-10.259	.0001	.017
DNOV	-.141	-12.073	.0001	.012
advb	.002	0.763	.4478	.002
advg	-.0004	-1.802	.0753	.0002
rho	-.153	1.392	.1180	.110
c	.7			
L	.001			
s	.7			
H	.3			

Note: rho is the first-order autocorrelation coefficient.
Adjusted R^2 = 0.97
Number of observations = 101
Degrees of freedom = 80

the quantity demanded of natural cheese would decline by about 12 percent. The own-price elasticity for processed cheese is estimated to be about -0.7, indicating that a 10-percent increase in price would cause about a 7-percent decrease in quantity purchased. Both own-price variables are significant at acceptable levels (greater than 5 percent). The income elasticities for natural and processed cheese are estimated to be about 1.0 and 0.05. Thus, natural cheese purchases are more responsive to income changes than are processed cheese purchases. The income elasticity for natural cheese is significant at a level greater than 1 percent, but the income elasticity for processed cheese is not statistically different from zero. These elasticities indicate that a 10-percent increase in income would cause about a 10-percent increase in the quantity of natural cheese purchased and a 0.5-percent increase in processed cheese purchases, other factors constant.

Table 7--Summary of processed cheese estimates, January 1982-June 1990

Source	Estimated b values	T for H:b=0	Prob T	Standard error of estimate
Intercept	-1.410	-2.026	0.0456	0.696
log(pn)	.235	1.333	.1859	.177
log(pp)	-.744	-3.208	.0018	.232
log(pi)	.360	2.948	.0040	.122
log(pm)	.867	3.036	.0031	.286
log(Y)	.046	.542	.5888	.085
d	-.002	-2.270	.0255	.001
adv	-.299	-2.379	.0255	.122
rho	-.592	-7.086	.0001	.083
c	.1			
L	.9			

Note: rho is the first-order autocorrelation coefficient.
Adjusted R^2 = 0.80
Number of observations = 101
Degrees of freedom = 93

The estimated cross-price elasticities between quantities of natural cheese purchased and the prices of processed cheese and meat are both 0.8. Both variables are statistically significant at the 1-percent level or better. The cross-price elasticities measure the extent that natural cheese purchases respond to a 1-percent change in the price of the substitute or complementary good, holding other factors constant. A positive cross-price elasticity suggests that two commodities are substitutes. A negative cross-price elasticity suggests that two commodities are complements. The estimated cross-price elasticities between processed cheese purchases and the prices of natural cheese, meat, and imitation cheese are about 0.2, 0.9, and 0.4. Only the natural cheese cross-price elasticity is not statistically significant. The meat and imitation cheese coefficients are statistically significant at levels greater than 1 percent. The estimated coefficients for Government donations in the demand equations are -0.002 for both natural and processed cheese. Both donation coefficients are statistically significant at the 5-percent level.

The monthly dummy variables in the natural cheese equation measure month-to-month differences in quantities purchased in relation to December's purchases, the base month. All monthly dummy variables are statistically significant at usual confidence levels and have negative signs. The negative signs indicate that purchases of natural cheese are higher in December than in other months. Monthly dummy variables were initially entered into the processed cheese equation. However, statistical tests indicated that as a group they were not significant. Next, we tried a dummy variable representing the summer months, but it was also insignificant.

The advertising constants, k's, in all equations were set equal to 0.0001. A small value for the parameter in relation to the magnitude of the advertising variable is necessary to avoid distorting the underlying relationship between

variable is necessary to avoid distorting the underlying relationship between advertising expenditures and the purchase behavior. This constant, k, represents a latent or unobserved component such as word-of-mouth advertising that exists in the absence of advertising expenditures and would generally be expected to be small when compared with the direct effect. We tried smaller values of k, but results remained relatively constant. The value of k is particularly important for simulating the effects of promotion on sales, and determining its value remains a difficult empirical issue (see Kesecker and Wu, 1982, and Wu and Kesecker, 1985).

Branded and generic advertising expenditures were initially entered separately in the processed cheese equation. This formulation consistently led to a deterioration of the model in terms of incorrect signs of the coefficients on the advertising variables, implying that advertising may have a negative effect on purchases. An examination of quarterly Leading National Advertisers data revealed that one company dominates the advertising of processed cheese products, and a high percentage of these promotion expenditures were for just a few products. Thus, in the case of processed cheese, branded advertising may function more nearly as a generic form of promotion than as a branded form.

The estimated coefficient for the generic advertising variable has the correct sign in the natural cheese equation and is significant at the 10-percent level (table 6). The coefficient on the branded advertising variable has a positive sign but is not statistically significant, suggesting that branded advertising may shift demand from natural cheese to processed cheese. The estimated parameters, c and L, in the natural cheese equation indicated that only generic advertising in the current month influences consumption. In other words, past advertising does not affect current consumption. Dropping the branded advertising variable from the model did not significantly improve the other parameter estimates.

The advertising (combined branded and generic) coefficient in the processed cheese equation had the correct sign and is statistically significant at the 5-percent level (table 7). The parameters c and L in the processed cheese equation imply that current-period advertising most affects consumption, but the weights on past advertising expenditures decline slowly, with advertising expenditures 12 months ago having about 40 percent of the effect of current-period advertising. This strong effect of past advertising expenditures may be somewhat implausible from an intuitive standpoint, although there is no theoretical evidence on the length of the advertising carryover effect.

Cheese Entry and Exit Equations

Parameter estimates of the entry and exit curves for natural cheese are found in tables 8 and 9. In the equation for the proportion of all households purchasing natural cheese, all variables have the expected sign, and most are significant at the 10-percent level or greater. Specifically, a 10-percent increase in the price of natural cheese reduced the proportion of all households in the market by about 3 percent. A 10-percent increase in the price of processed cheese increased the proportion of households purchasing natural cheese by about 4 percent. A 10-percent increase in the CPI for meats increased the proportion of households entering the natural cheese market by about 4 percent. A 10-percent increase in the amount of Government donations reduced the proportion of households purchasing natural cheese by less than 1 percent.

The income variable was not statistically significant. All dummy variables were statistically significant and negative except the one for February, which was positive and insignificant, and November, which was negative and insignificant.

We found that the generic advertising variable was statistically significant at a level greater than 1 percent, and that it had the correct sign. However, the branded advertising coefficient was statistically insignificant. The three most statistically important variables affecting the proportion of households entering the natural cheese market, other than dummy variables, were the CPI for meat, the price of processed cheese, and generic advertising.

In the average-quantity-purchased equation, most variables were statistically significant. Neither advertising variable increased the average quantity of

Table 8--Estimates of the proportion of households purchasing natural cheese, January 1982-June 1990

Source	Estimated b values	T for H:b=0	Prob T	Standard error of estimate
Intercept	2.450	1.884	0.0632	1.3005
log(pn)	-.307	-1.723	.0888	.1780
log(pp)	.422	3.315	.0014	.1272
log(pm)	.406	6.373	.0001	.0636
log(Y)	.226	1.394	.1672	.1620
d	-.001	-2.491	.0148	.0003
t	-.002	-4.256	.0001	.0004
DJAN	-.084	-7.554	.0001	.0111
DFEB	.005	.248	.8048	.0188
DMAR	-.079	-7.822	.0001	.0101
DAPR	-.057	-5.708	.0001	.0100
DMAY	-.117	-10.967	.0001	.0106
DJUN	-.097	-8.988	.0001	.0107
DJUL	-.144	-12.607	.0001	.0114
DAUG	-.121	-8.988	.0001	.0126
DSEP	-.068	-5.952	.0001	.0114
DOCT	-.086	-7.681	.0001	.0111
DNOV	-.010	-1.272	.2070	.0077
advb	.0005	.354	.7240	.0015
advg	-.0004	-2.862	.0054	.0001
rho	.162	1.475	.1659	.1096
c	.7			
L	.001			
s	.7			
H	.3			

Adjusted R^2 = 0.97
Number of observations = 101
Degrees of freedom = 80

cheese bought by households already in the cheese market. Advertising apparently induces households to enter the market but does not significantly affect the average quantity of their purchases.

Of the significant variables, a 10-percent increase in the price of natural cheese reduced the average amount purchased by approximately 8 percent. A 10-percent increase in the CPI for meats increased natural cheese purchases by purchasing households by about 4 percent, and a 10-percent increase in income increased average purchases by about 6 percent, other factors constant.

Results for the entry and exit equations for processed cheese are in tables 10 and 11. In the equation for the proportion of households purchasing processed

Table 9--Estimates of the average quantity of natural cheese purchased by purchasing households, January 1982-June 1990

Source	Estimated b values	T for H:b=0	Prob T	Standard error of estimate
Intercept	-5.406	-3.142	0.0023	1.7206
log(pn)	-.839	-3.668	.0004	.2287
log(pp)	.376	2.226	.0261	.1658
log(pm)	.427	4.777	.0001	.0893
log(Y)	.649	3.028	.0033	.2142
d	-.001	-1.982	.0509	.0004
t	-.003	-5.144	.0001	.0005
DJAN	-.064	-4.604	.0001	.0140
DFEB	-.132	-5.384	.0001	.0245
DMAR	-.083	-6.472	.0001	.0129
DAPR	-.126	-9.785	.0001	.0129
DMAY	-.101	-7.394	.0001	.0137
DJUN	-.124	-8.958	.0001	.0138
DJUL	-.126	-8.601	.0001	.0146
DAUG	-.115	-7.136	.0001	.0161
DSEP	-.126	-8.623	.0001	.0146
DOCT	-.093	-6.533	.0001	.0142
DNOV	-.098	-10.347	.0001	.0095
advb	.001	.459	.6477	.0021
advg	-.00002	-.134	.8941	.0002
rho	-.283	-2.657	.0091	.1066
c	.7			
L	.001			
s	.7			
H	.3			

Adjusted R^2 = 0.91
Number of observations = 101
Degrees of freedom = 80

Table 10--Estimates of the proportion of households purchasing processed cheese, January 1982-June 1990

Source	Estimated b values	T for H:b=0	Prob T	Standard error of estimate
Intercept	-3.844	-6.075	0.0001	0.6327
log(pn)	.476	3.053	.0030	.1561
log(pp)	.275	1.356	.1785	.2030
log(pi)	.225	2.086	.0397	.1077
log(pm)	.809	3.421	.0009	.2365
log(Y)	.988	12.694	.0001	.0779
d	-.001	-1.196	.2348	.0007
advb	-.197	-2.031	.0451	.0969
rho	-.521	-5.891	.0001	.0885
c	.1			
L	.9			

Adjusted R^2 = 0.76
Number of observations = 101
Degrees of freedom = 93

Table 11--Estimates of the average quantity of processed cheese purchased by purchasing households, January 1982-June 1990

Source	Estimated b values	T for H:b=0	Prob T	Standard error of estimate
Intercept	-0.562	-1.255	0.2127	0.4475
log(pn)	.046	.451	.6532	.1013
log(pp)	-.589	-4.581	.0001	.1286
log(pi)	.144	2.112	.0370	.0684
log(pm)	.320	2.445	.0164	.1310
log(Y)	.017	0.308	.7591	.0554
d	-.001	-3.368	.0011	.0004
advb	-.109	2.203	.0300	.0493
rho	-.326	3.323	.0012	.0981
c	.1			
L	.9			

Adjusted R^2 = 0.78
Number of observations = 101
Degrees of freedom = 93

cheese, the price of the processed cheese variable had the wrong sign and was statistically insignificant. The price of the natural cheese variable had the expected sign and was significant. The price of the imitation cheese variable was significant at a level greater than 5 percent and had the expected sign.

A 10-percent increase in the price of imitation cheese would increase the proportion of households entering the market for processed cheese by about 2 percent.

The CPI for meats and income had the expected signs and were significant at levels greater than 1 percent. A 10-percent increase in the CPI for meats would increase the proportion of households in the processed cheese market by about 8 percent, while a similar increase in income would increase the proportion by about 10 percent. Advertising had the expected sign in this equation and was statistically significant. A 10-percent increase in generic advertising would increase the proportion of households in the processed cheese market by about 2 percent.

In the equation for the average quantity bought by households in the processed cheese market, the variable for the price of processed cheese had the correct sign and was significant at a level greater than 1 percent (table 11). In addition, the variables for the price of imitation cheese, the CPI for meats, and donations were all significant at the 5-percent level or greater. However, the price of natural cheese and income were insignificant.

The advertising variable in the average-quantity-purchased equation was statistically significant at a level greater than 5 percent. A 10-percent increase in generic advertising would increase the average quantity purchased by about 1 percent. Advertising apparently increases the amount of average purchases made by households in the processed cheese market and induces entry into the market.

Simulations of the Cheese Demand Equations

The statistical error associated with each estimate of the natural and processed cheese demand equations is small enough to permit a statistically founded conclusion that advertising increases the demand for cheese. Thus, we can use these estimated-demand equations for generic advertising with sufficient confidence to simulate the total effect of advertising on cheese purchases. We used the following procedures to simulate the effect on cheese purchases of increased generic advertising after passage of the act. First, we simulated per capita consumption from the natural and processed cheese equations using the actual levels of generic advertising. Next, we simulated per capita consumption by assuming that generic advertising remained at the monthly per capita levels of the year prior to the implementation of the act, September 1983-August 1984. For this procedure, we assumed that, in the absence of the act, generic advertising dollars spent would have increased over time at the same rate as inflation in media costs. We then estimated per capita consumption of natural and processed cheese on a monthly basis over the period September 1984-June 1990. The only factor that differed between the simulations was the level of generic advertising expenditures. We kept all other factors at actual levels observed during the period.[1] The difference

[1] This control implies that the behavior of branded cheese advertisers did not change in response to the expanded generic programs. In reality, branded advertising dollars increased dramatically when the act became effective. If branded advertising increased as a result of the act, then our simulation underestimates the effect of the legislation.

in per capita consumption between the simulations is an estimate of the effect of the act. We then obtained the national effect of the act by expanding the per capita effect by total population (table 12).

Results of the simulations indicate that the increased generic advertising expenditures due to enactment of the act increased national consumption of natural cheese at home by 22.8 million pounds (table 12). In contrast, the MRCA data indicate that during September 1984-June 1990, total national consumption of natural cheese at home was 6.6 billion pounds. Similar estimates from the processed cheese model indicate that increased generic advertising caused by the act increased national consumption of processed cheese at home by 229.2 million pounds. The MRCA data indicate that total national consumption of processed cheese at home during September 1984-June 1989 was 4.6 billion pounds.

Generic advertising appears to be much more effective in increasing total consumption in the processed cheese equation because of the sustained effect of past advertising on current consumption.

We also performed simulations to estimate the effect of increasing (decreasing) real generic advertising expenditures by 10 percent above (below) the actual amount spent during September 1984-June 1990. These results indicate that a 10-percent increase or decrease in generic advertising

Table 12--Summary of model simulation results on the effect of regional and national generic cheese advertising on national at-home consumption, September 1984-June 1990

Item	Sales/advertising results
Total sales of natural cheese	6,629.5 million pounds
Total sales of processed cheese	4,573.3 million pounds
Estimated increase in national and regional advertising expenditures due to act	$233.4 million[1]
Natural cheese:	
Sales gain due to advertising	22.8 million pounds
As a share of total sales	.3 percent
Per advertising dollar	.1 pounds
Processed cheese:	
Sales gain due to advertising	229.2 million pounds
As a share of total sales	5.0 percent
Per advertising dollar	1.0 pounds

[1]Includes 25 percent of the calcium advertising of the National Dairy Promotion and Research Board.

expenditures for cheese would have virtually no effect on natural cheese consumption. A 10-percent increase (decrease) in advertising expenditures, however, would have increased (decreased) processed cheese consumption by 18.1 (19.6) million pounds.

Similar procedures were used to simulate the effect on cheese purchases of changes in other model variables. First, we simulated per capita consumption from the natural and processed cheese equations using the actual levels of all variables. Next, we simulated per capita consumption assuming that the variable of interest, say natural cheese prices, remained at the monthly levels of the year prior to the act, September 1983-August 1984. The only factor that differed between the simulations was the level of the variable under study. We kept all other factors at actual levels observed during the period. The difference in per capita consumption between the simulations is an estimate of the effect of changes in an individual variable. We then obtained the national effect by multiplying the per capita effect by the total population (table 13).

Falling real natural cheese prices, down 8.1 percent on average from September 1983-August 1984 to September 1984-June 1990, increased natural cheese sales by about 645.4 million pounds, all other variables constant. This change in natural cheese prices reduced processed cheese sales by about 96 million pounds because natural and processed cheeses are substitutes. A 5.7-percent decline in real processed cheese prices between these periods increased processed sales by 204.4 million pounds. A 1.9-percent drop in real prices of meat, poultry, and fish reduced natural cheese sales by 110.7 million pounds and processed cheese sales by 80.6 million pounds. Rising real consumer income, up 8.2 percent, increased natural cheese sales approximately 486.8 million pounds and processed cheese sales by 16.9 million pounds.

Table 13--Summary of model simulation results on the effect of changes in selected variables on consumption of natural and processed cheese at home, September 1984-June 1990

Item	Sales results
Sales gain or loss due to changes in selected variables:	
Natural cheese--	Million pounds
Decreasing price of natural cheese	645.4
Decreasing price of processed cheese	-353.2
Decreasing price of meat, poultry, and fish	-110.7
Increasing income	486.8
Processed cheese--	
Decreasing price of natural cheese	-96.0
Decreasing price of processed cheese	204.4
Decreasing price of meat, poultry, and fish	-80.6
Increasing income	16.9

Study Limitations

Several factors limit the conclusions that can be drawn from this study. First, MRCA data measure only household purchases of cheese at retail establishments for off-premise consumption. Cheese consumed away from home or as a component of a food product is not measured by MRCA. USDA per capita disappearance data suggest that cheese use has increased over time, but the MRCA data show it declining. This contradiction suggests that the downward trend in purchases for consumption at home is more than offset by growth in eating away from home and the consumption of cheese in food mixtures. Generic advertising may affect consumption of cheese away from home and food mixtures containing cheese that are not measured with the MRCA data. Thus, our estimates may understate the total effect of generic advertising.

Another limitation of the current analysis is the relatively short time that the National Dairy Board and qualified regional programs have been advertising cheese and fluid milk. In September 1984, when the National Dairy Board and other groups began generic advertising for cheese, the absolute amount of generic advertising expenditures for cheese rose dramatically. For example, in September 1984 about $4 million was spent on generic cheese promotion, compared with less than $900,000 in September 1983.

Another area that requires attention is branded advertising expenditures. The cheese market appears to be unique in that one firm apparently dominates branded advertising. At times, a large share of the branded advertising expenditures is for only a couple of products. The issue concerns how to treat branded advertising in econometric models of cheese demand when a single firm dominates the at-home market. Whether branded advertising should be modeled separately from generic advertising or treated as a form of generic advertising is an area for further research.

The issue of how best to model the effect of past advertising on current consumption should also receive more attention. This critical issue can significantly affect the simulated effects of advertising expenditures on consumption.

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Appendix: Definition of Regions

1. Federal Milk Order #1: New England
2. Federal Milk Order #4: Middle Atlantic
3. Federal Milk Order #7: Georgia
4. Federal Milk Order #13: Southeast Florida
5. Federal Milk Order #40: Southern Michigan
6. Federal Milk Order #64: Greater Kansas City
7. Federal Milk Order #68: Upper Midwest
8. Federal Milk Order #126: Texas
9. Federal Milk Order #137: Eastern Colorado
10. Federal Milk Order #139: Great Basin
11. Virginia State Order: Northern Virginia
12. California State Order

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